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*March 29, 2006*

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APPLICATION NUMBER: 60/464,879

FILING DATE: *April 23, 2003*

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THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS *US60/464,879*



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This is a Request for Filing a PROVISIONAL APPLICATION FOR PATENT under 35 U.S.C. § 111(b)(2) - FILED 4/23/03

4-24-03	Docket Number -	UA449	Type a plus sign (+) inside this box -	+
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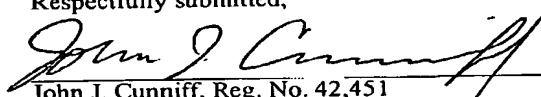
TITLE OF THE INVENTION (280 characters max)	
SEQUESTERED REACTIVE MATERIALS	

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ENCLOSED APPLICATION PARTS (check all that apply)			
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METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT (check one)	
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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government:  
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☐ Yes, the name of the U.S. Government agency and the Government contract number are: \_\_\_\_\_

Respectfully submitted,  
  
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Additional inventors are being named on separately numbered sheets attached hereto.

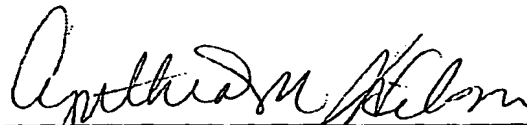
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Cynthia M. Wilson Sec'y to John J. Cunniff

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## **Sequestered Reactive Materials**

The invention is a method for making materials or material structures. The materials sequester or contain substances which can react. Addition of a control substance to the materials or material structure release the reactants and allow a useful reaction to occur. The preferred method for sequestering the reactants is to incorporate the reactants into nanofibers by a process such as electrospinning. In some cases the nanofiber may be made of one of the useful reactants.

This is a broad invention that includes many kinds of reactants, many kinds of fibers that sequester the reactants, many kinds of solvents, signaling substances, radiation, heat, mechanical forces, and the like which initiate, modulate, accelerate, quench, (and other such) the reactions to serve needs such as wound treatment, analytical and synthetic chemistry, biomedical, and many more.

The reactive substances may be sequestered inside the nanofibers (or larger fibers, preferably mixed with nanofibers) as particles, dissolved molecules, fibrous "skeletons" which may be created during spinning of the nanofibers, as a uniform crating or as beads on a fiber, as ribbons or tubes, as gas filled pores. Non-reactive coatings can sequester reactive nanofibers, and particles. The utilization of fibers, preferably nanofibers, or electrospun nanofibers, distinguishes the invention from prior art.

Many substances may be sequestered in the nanofiber structure in such a way that a complex series of chemical reactions can occur, and be accelerated, decelerated, modulated, or stopped predictably or in response to other substances which may be added, or which may be found in the vicinity of the reaction.

The invention includes a large class of "smart materials" which respond in useful or "intelligent" ways to substances and stimuli that act upon the material. A fabric made of an open weave fabric could be converted to a thermally insulating foam, for

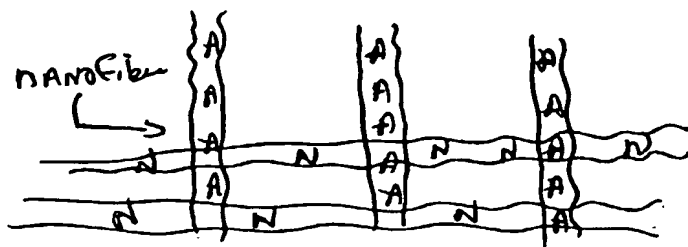
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example.

Some of the fibrous components of the invented materials and material structures can remain intact to preserve mechanical strength, electrical conductivity, or rubber elasticity, for example.

The fibrous structure of these materials allow rapid access of control substances and rapid transport of reactants through the structure. The fibrous structure allows the materials to conform to surfaces with complicated shapes, or to be easily formed into other useful shapes.

#### Specific Examples



A = Ascorbic Acid

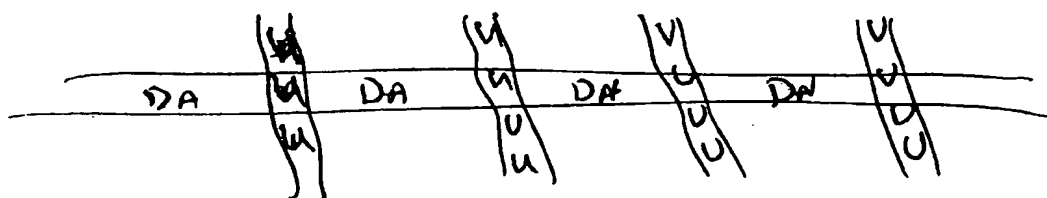
N =  $K^+NO_2^-$  (nitrite)

A nanofiber assembly contains at least two types of fibers, each sequestering a reactive component. In this example, fiber one contains ascorbic acid; fiber two contains potassium nitrite. Ascorbic acid and potassium nitrite may or may not be soluble in the polymer solution prior to electrospinning. Fiber polymers may or may not dissolve in water. Fiber mat formed above, when exposed to moisture, releases ingredients to give ascorbic acid and  $NO_2^-$ , which react to form nitric oxide (NO). Alternatively, nitrate and/or ascorbic acid may be immobilized such as by being adsorbed onto an ion exchange resin bead, which is then incorporated into polymer fibers or nanofibers. One or more of the bead-bound reactive compounds, will therefore not leach from the fibers on exposure to moisture, but

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will only react *in situ* on the bead. For example, ascorbic acid may be incorporated into a first nanofiber and ion exchange resin bead-bound nitrite may be incorporated into a second nanofiber. Neither component will leach from the fibers in the absence of moisture. However, on exposure to a solvent for the polymer of the first fiber, or another compound which allows release of ascorbic acid from the first fiber, the ascorbic acid will be released and react with the bound nitrite, releasing nitric oxide. Intervening layers of fibers may also be incorporated to regulate the migration of ascorbic acid to the nitrite containing fibers.

In another example, one type of fiber contains a urethane prepolymer, while a second fiber contains a crosslinker as shown schematically below.



U = urethane prepolymer (Hypol™)

DA = diamine (crosslinker)

No reaction will occur until the nanofibers dissolve or swell in solvent.

Fiber assemblies as described above are envisioned as being useful in nitric oxide-releasing medical dressings for the treatment of wounds and other lesions of the skin such as warts. This method may also be useful in other fields where the sequestration of reactive components is desired, such as in the creation of epoxy-type adhesives.

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